

THE ECOLOGY OF PHYTOPLANKTON BLOOMS IN
MORICHES BAY AND GREAT SOUTH BAY,
LONG ISLAND, NEW YORK¹

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In recent years Great South Bay and Moriches Bay have supported an extremely heavy growth of phytoplankton which characteristically appears early in the spring and persists throughout the summer and fall. At the peak of their growth, the contributing organisms have been found to exceed concentrations of ten million cells per ml., and the resulting turbidity may reduce Secchi disc transparency to less than one foot in places.

Records maintained since 1922 by Mr. J. B. Glancy show that the recurrent annual populations of algae in Great South Bay have consisted almost without exception of small, unicellular, green organisms 2-4 μ in diameter, which have been referred to locally as "small forms." This type of population differs greatly from the mixed communities of diatoms, green flagellates, and dinoflagellates which are typical of the plankton flora in other bays and estuaries of the same general region. Another striking feature is the persistence of the "small form" populations throughout the spring, summer, and fall, in marked contrast to the seasonal succession of dominant species which is commonly observed elsewhere. It is the purpose of this report to analyze the physiological factors which may account for the dominance of "small forms" in the recurrent plankton blooms.

These dense growths of algae have greatly reduced the value of the surrounding region as a recreational area, and are also considered to be the principle cause of the failure of what was formerly a prosperous oyster industry in Great South Bay. Correlated with and suspected as a cause of the algal blooms is the existence of a large duck industry which now consists of over 40 individual farms centered along the tributary streams and coves of Moriches Bay. These farms are so situated that their waste products eventually enter the bays, greatly enriching the water and presumably creating conditions conducive to the development of the plankton blooms.

The results of a study of various aspects of the hydrography, chemistry, and biology of Great South Bay and Moriches Bay, will appear elsewhere (Ryther, unpublished data). This investigation has revealed that the embayments under consideration represent a unique ecological environment which results partly from pollution contributed by the surrounding duck farms, and partly from the topographic and hydrographic features of the area. The pollution not only provides an extensive fertilization of the bay waters with nutrients essential to phytoplankton growth, but, in addition, the presence of organic nitrogen compounds and the low ratio of nitrogen to phosphorus in the pollutants create conditions which differ

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considerably from the chemical composition of natural sea water. The shallow nature of the embayments contributes to the development of abnormally high water temperatures which may reach 30° C. during the summer months. Their extremely low flushing rate results in the retention for long periods of time of both the pollutants and their entraining fresh water, which further builds up the concentrations of nutrients and the resulting phytoplankton crop and also reduces salinities to approximately 50% of normal sea water in the open embayments and less than 10% in the estuaries.

This report includes the results of experiments performed with the two dominant species of "small forms," and, for contrast, with the common neritic diatom, *Nitzschia closterium*. Growth rates of these algae were studied in relation to the temperature, salinity, and nutrient conditions peculiar to Great South Bay and Moriches Bay as described above. The results of these experiments were then related to the distribution of the "small form" population and associated physical and chemical conditions existing in the embayments.

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CULTURE METHODS

The "small form" population of 1952 and 1953 consisted principally of two species of algae. That which was the more numerous was identified by Dr. Wm. Butcher as his recently described *Nannochloris atomus* (Butcher, 1952). The other species was tentatively placed by Dr. Ralph Lewin in the genus *Stichococcus*, possibly *S. cylindricus* Butcher.

Because of their similarity of appearance, it was impossible to distinguish between the two species in routine examinations of the natural population. Consequently they will be considered together as a single community and referred to collectively as the "small form" population.

The *Nannochloris*, *Stichococcus*, and *Nitzschia* used in the experiments were isolated from water samples collected from Great South Bay. Pure cultures were obtained by the agar streak method incorporating the use of penicillin (200 units/ml.) and streptomycin (10–20 units/ml.) in the enriched agar. Colonies isolated from streaks were transferred several times on the antibiotic agar and then inoculated into liquid media.

Pure cultures were used in all experiments involving nutrient studies, while cultures of *Nannochloris* and *Stichococcus* used in the temperature and salinity experiments were unialgal but not bacteria-free.

Growth studies were made with algal cultures grown in 300 ml. of media in 500-ml. Erlenmeyer flasks. Lighting was provided by a bank of mixed daylight and white fluorescent lamps which produced 500 foot candles of illumination.

Temperature was controlled by keeping cultures immersed in running tap water, which provided a range of 20–30° C. over a six-months period by varying the rate of flow of the water. This method permitted control to $\pm 2^\circ$ C. for periods of one to two weeks, the normal duration of the experiments. Cultures grown at temperatures of 5–15° C. were maintained to a variability of $\pm 1^\circ$ C. in an illuminated, constant temperature box. Except where the effect of temperature upon growth was being studied, cultures were routinely grown at 18–22° C.

The same basic medium was employed for the culture of all three species of algae, and consisted of a modification of the artificial sea water of McClendon *et al.* described in Sverdrup, Johnson and Fleming (1942), enriched with N, P, Si, and Fe. At full strength (34.62‰) it consists of the following, in parts per thousand:

NaCl	26.726	H ₃ BO ₃	0.058
MgCl ₂ ·6H ₂ O	2.260	Na ₂ SiO ₃ ·9H ₂ O	0.020
MgSO ₄ ·7H ₂ O	3.248	NH ₄ Cl	0.053
CaCl ₂	1.153	Na ₂ HPO ₄ ·12H ₂ O	0.020
KCl	0.731	Fe Citrate	0.001
NaHCO ₃	0.198		
KBr	0.058		

Since the growth of *Nitzschia* is relatively poor in ammonia-nitrogen, as will be demonstrated, NH₄Cl was replaced with 0.10‰ KNO₃ in media used for growing the diatom. Several of the other constituents have been altered in concentration or replaced with other ingredients in the various experiments, as will be discussed below.

Growth in all experimental cultures was determined by cell counts with a Levy hemacytometer. Cultures were grown for periods of 10 days to two weeks, and cell counts were made at intervals of two to three days.

The growth rate, expressed as divisions per day (*d*), was calculated for the entire period of growth from the expression:

$$d = l_n \frac{C_t}{C_o} \times \frac{1}{t l_n 2},$$

where *C_t* and *C_o* are cell concentrations at times *t* and *o*, respectively.

EXPERIMENTS AND THEIR APPLICATION TO FIELD OBSERVATIONS

1. Nutrients

A. Experiments

A series of laboratory experiments was conducted to determine the relative growth rates of *Nannochloris*, *Stichococcus*, and *Nitzschia* in each of several different forms of nitrogen. Pure cultures of the three species were used, and each was grown at its optimum salinity, as will be discussed in a later section. All three algae were grown in media containing one mg. atom per liter of nitrogen in each of the following forms: nitrate, nitrite, ammonia, urea, uric acid, l-cystine, asparagin, and glyocoll. The resulting growth rates, in divisions per day, are given in Table I.

TABLE I

The effect of the nitrogen source upon the growth rates of Nannochloris, Stichococcus, and Nitzschia

Nitrogen source (1 mg. A N/L)	Growth rate: Divisions per day		
	<i>Nannochloris</i>	<i>Stichococcus</i>	<i>Nitzschia</i>
NO ₃	0.54	0.57	0.37
NO ₂	0.65	0.57	0.40
NH ₃	0.72	0.61	0.04
Urea	0.62	0.56	0.21
Uric acid	0.68	0.59	0.23
l-cystine	0.77	0.62	0.00
Asparagin	0.68	0.62	0.15
Glycocoll	0.66	0.61	0.07

It may be seen that the diatom grew about equally well in nitrate and nitrite, poorly in ammonia, and slowly or not at all in the organic N compounds. Both *Nannochloris* and *Stichococcus* showed good growth in all of the forms of nitrogen tested. However, the growth rate of both species in nitrite and nitrate was slightly lower than that in ammonia, and, in general, was less than growth rates in the organic compounds. The best growth of *Nannochloris* was observed in cultures containing l-cystine.

TABLE II

The effect of the N:P ratio upon the growth rates of Nannochloris, Stichococcus, and Nitzschia

N:P ratio (by atoms)	Growth rate: Divisions per day		
	<i>Nannochloris</i>	<i>Stichococcus</i>	<i>Nitzschia</i>
15:1	0.68	0.53	0.39
5:1	1.32	0.88	0.40

In another series of experiments, growth rates of the three species of algae were determined in media containing the same concentrations of nitrate-nitrogen (one mg. atom per liter) but two different concentrations of phosphate-phosphorus (0.066 and 0.200 mg. atoms per liter). By varying the concentrations of phosphorus in this manner, the resulting N:P ratios by atoms in the two media were 15:1 and 5:1, respectively.

In this experiment, increasing the P concentration, or lowering the N:P ratio, had no effect upon the growth of the diatom, *Nitzschia*, but approximately doubled the growth rates of *Nannochloris* and *Stichococcus* (Table II).

B. Application to field observations

Richards (unpublished data) measured the nitrogen present as uric acid, ammonia, nitrite, and nitrate in the duck farm effluents, the tributaries to Moriches

Bay receiving these effluents, and in Moriches and Great South Bays on August 21, 1952. His analyses showed that uric acid could be detected only in the duck farm effluents, ammonia was present in both the effluents and the tributary streams, while nitrite and nitrate were found nowhere except as traces. No appreciable concentrations of inorganic N in any of the forms tested for was found in either Moriches Bay or Great South Bay.

Phosphorus, on the other hand, appears to have been present in excess of the requirement of the phytoplankton during most of the year, not only in the polluted estuaries, but also throughout the bay waters. Filtered water samples collected from several locations in Great South Bay and Moriches Bay failed to support the growth of *Stichococcus*, if untreated or enriched with phosphate. However, dense growth of the alga occurred in all samples if enriched with ammonia-N indicating that the latter was the principal limiting factor to the growth of the algae population.

The population maxima normally occurred in Moriches Bay and its polluted tributaries. The distribution pattern of the organisms in Great South Bay and Shinnecock Bay is strongly suggestive that their presence in these waters was largely the result of the seaward flushing of Moriches Bay water, and that growth was principally confined to an area close to the source of the nutrient rich duck farm pollutants.

In its original state in the duck wastes, nitrogen occurs as excreted uric acid and amino compounds contained in the undigested food residues. Investigations in this laboratory by Vaccaro, Norton and Plunkett (unpublished) have disclosed that bacteria present in the duck farm effluents are capable of decomposing uric acid with great rapidity. In water samples collected from these effluents, the contained uric acid was found to decrease to 10% of its original concentration in an average of 15 hours at 2° C. The nitrogenous end products of this decomposition were not investigated, but Copeman and Dillman (1937) observed that the decomposition of the uric acid of guano in water was accompanied by an increase in ammonia from 32.2% to 85.0% of the total nitrogen in four days.

According to the classical concept of the nitrogen cycle of the sea, the decomposition of organic nitrogen to ammonia is followed by the nitrification of the ammonia to nitrite and nitrate. This phase of the cycle appears never to occur to any appreciable extent in the Moriches Bay area. Since nitrogen is the limiting factor to the growth of the phytoplankton, it is utilized as quickly as it becomes available and before decomposition to nitrite and nitrate can occur.

It follows that those organisms will have a distinct advantage which are able to utilize the nitrogen in the earliest stages of its decomposition. The laboratory experiments have demonstrated that *Nannochloris* and *Stichococcus* are particularly well adapted to growth in organic nitrogen and its early decomposition products. In contrast, the diatom, *Nitzschia closterium*, grew poorly or indifferently in these N forms. The advantage of the "small forms" over the latter in the Moriches Bay environment is therefore obvious.

Nitrogen and phosphorus are contained in duck faeces at a ratio of approximately 3.3 atoms of nitrogen to one atom of phosphorus. Total N and total P data from the tributaries of Moriches Bay and from the bay itself show N:P ratios ranging from 2.3:1 to 4.4:1 (Richards, unpublished data). Approximately

one-half of the total phosphorus consisted of inorganic phosphate in these analyses. On the other hand, no appreciable concentrations of available nitrogen were found anywhere in the bay waters, as previously discussed. If it is assumed that half of the total phosphorus and all of the total nitrogen were incorporated in particulate matter, which consisted principally of algal cells, then the N:P ratio of the phytoplankton would range from 4.6:1 to 8.8:1 by atoms.

Various authors have pointed out that the ratio of nitrogen to phosphorus in open ocean water is rather constant at approximately 15:1 by atoms, which is closely reflected in the ratio of these elements in marine phytoplankton (Redfield, 1934; Cooper, 1937, 1938; Fleming, 1940). Harvey (1940) found that natural populations of diatoms utilized about 20 atoms of nitrogen to one atom of phosphorus.

Ketchum and Redfield (1949) showed that laboratory cultures of *Nitzschia closterium* contained N and P at a ratio of 11.6:1, but cultures of six species of Chlorophyta, including *Stichococcus bacillaris*, had N:P ratios ranging from 3.5:1 to 6.6:1, or two to three times as much phosphorus per atom of nitrogen as the diatoms. This compares favorably with the estimated N:P ratio of the phytoplankton of Moriches Bay which consisted predominantly of the Chlorophyta, *Stichococcus* and *Nannochloris*.

These data indicate that there is a basic difference between the chemical composition of the green algae, typical of fresh and brackish water, and oceanic diatoms, at least with respect to the N:P ratio in the cells. The growth studies bear out this contention by demonstrating the fact that the Chlorophyta grow much more rapidly in water containing three times as much phosphorus per atom of nitrogen as normal sea water, while this increase in phosphorus has no effect upon the growth of the diatom, *Nitzschia closterium*.

The N:P ratio of the polluted water of Moriches Bay and its environs thus appears to be another factor favoring the growth of the "small forms" and their competition with organisms similar to *Nitzschia* in their nutritional requirements.

2. Salinity

A. Experiments

To determine the effect of salinity upon the growth rates of *Nannochloris*, *Stichococcus*, and *Nitzschia*, each species was grown in a series of dilutions of the artificial medium described above. This series consisted of 100, 75, 50, 25, and 1 per cent solutions of the indicated concentrations of NaCl, MgCl₂, MgSO₄, CaCl₂, and KCl. The concentrations of the other ingredients, which together account for less than 0.50/100, were not altered to avoid possible deficiencies of those nutrients.

The salinities of the resulting solutions, in ‰, totaled, respectively, 34.51, 25.91, 17.44, 8.91, and 3.80, with an additional 0.048‰ in each of the *Nitzschia* media as a result of replacing NH₄Cl with KNO₃.

These experiments indicate a salinity optimum at or near that of full sea water for *Nitzschia*, a typical marine species, while the "small forms" grow well within a wide range of salinities, with optima at about 50‰ sea water, and may be considered as brackish water species (Table III).

TABLE III

The effect of salinity upon the growth rates of Nannochloris, Stichococcus, and Nitzschia

Salinity: ‰	Growth rate: Divisions per day		
	<i>Nannochloris</i>	<i>Stichococcus</i>	<i>Nitzschia</i>
34.51	0.45	0.44	0.40
25.91	0.61	0.55	0.34
17.44	0.69	0.61	0.28
8.91	0.56	0.58	0.09
3.80	0.37	0.52	0.00

B. Application to field observations

The highest concentrations of "small forms" normally occurred in Moriches Bay in water of approximately 15‰ salinity, or close to the physiological optima of the organisms. While this does not imply that salinity was the factor controlling the distribution of the phytoplankton, particularly in view of the preceding discussion concerning the distribution of nutrients, it nevertheless represents another environmental condition favoring the growth of the "small forms" over that of the more typical marine forms.

Of still greater importance, however, is the fact that *Nannochloris* and *Stichococcus* were able to grow remarkably well within the entire range of salinities tested in the experimental cultures, in contrast to the diatom, which was unable to grow at all in the low salinity cultures. This is particularly significant in view of the wide range of salinities which were observed in Great South Bay and Moriches Bay and their tributaries. Over a million "small forms" per ml. were present throughout the late spring and summer in the upper Forge River, directly opposite a group of duck farms, in water of less than 1‰ salinity. In addition, evidence was obtained in the experiment described in Section 1B that nitrogen-enriched water from Fire Island Inlet (26‰ salinity) was able to support a prolific growth of *Stichococcus*.

The population which thus becomes established in the highly enriched rivers and estuaries is able to continue growth as it is borne out to sea until its source of nutrients becomes depleted. At no time does salinity limit its growth and thereby permit the succession of other forms.

3. Temperature

A. Experiments

Growth rates of the three algae were determined for cultures grown at temperatures ranging from 5° to 30° C. at intervals of 5° (Table IV). *Nitzschia* was grown in the full strength artificial medium (34.51‰) while the "small forms" were grown in the half-strength media (17.44‰) found to give optimum growth in the preceding section.

The diatom multiplied within a temperature range of 5–25° with optimum growth at 15°. Its division rate was relatively high at the lower limit of 5°, but decreased rapidly above 20°.

No appreciable growth of *Nannochloris* or *Stichococcus* occurred at temperatures of 10° or lower, but both species grew rapidly at temperatures of 15–30°. No clear-cut optimum could be detected between 15° and 25°, but growth rates of both "small forms" decreased considerably at 30°.

B. Application to field observations

When field studies were begun on April 1, a mixed diatom bloom occurred in the bays, which consisted of 890,000 *Leptocylindrus minimus*, 35,000 *Thallasiosira nana*, and 12,000 *Skeletonema costatum* per ml. at a station in central Moriches Bay. There were also present at that time 211,000 "small forms" per ml. On May 13 the situation was reversed, with "small forms" dominating the plankton and diatoms reduced to a total of 40,000 cells per ml. The latter subsequently disappeared from the plankton and did not reappear until the following February.

The principle cause of this succession of dominants appears to be temperature. Experimental evidence has shown that *Nannochloris* and *Stichococcus* are unable to grow appreciably at the 10° temperature which prevailed throughout the embayments on April 1, while the diatom, *Nitzschia*, maintained a relatively high growth rate at temperatures as low as 5°.

During the period of May–September, temperatures in Moriches Bay ranged from 13° to 30°. The growth experiments demonstrated that both *Nannochloris* and *Stichococcus* divide rapidly within that temperature range. The seasonal distribution of inorganic phosphorus in the Forge River at a station close to the source of pollution indicates that the heaviest enrichment of the bay waters also occurred during the same period of May–September. The situation therefore exists that during that part of the year when the bay is most heavily enriched with nutrients, temperatures may be expected which will fall approximately within the range for optimum growth of the "small forms."

The month of July, 1952, was characterized by abnormally high temperatures throughout the Long Island area. Water temperatures of the three embayments under consideration ranged from 28–30° during the July 22–23 survey. A

TABLE IV
The effect of temperature upon the growth rates of *Nannochloris*,
Stichococcus, and *Nitzschia*

Temperature: ° C.	Growth rate: Divisions per day		
	<i>Nannochloris</i>	<i>Stichococcus</i>	<i>Nitzschia</i>
5	0.00	0.00	0.29
10	0.14	0.12	0.42
15	0.65	0.48	0.48
20	0.80	0.48	0.40
25	0.71	0.43	0.19
30	0.32	0.26	0.00

decrease in the "small form" population at that time was generally observed throughout the area. This may be explained by the fact that the July temperatures exceeded the optima of the "small forms." The division rates of both *Nannochloris* and *Stichococcus* at 30° were observed to be approximately one half of that at 25° (Table IV). This population drop was obviously not associated with a nutrient depletion, as indicated by unusually high inorganic phosphorus concentrations on that date.

The presence of relatively large numbers of "small forms" between October and April, when temperatures were presumably too low to permit their growth, may be explained on the basis of the slow flushing time of Moriches Bay and the low death rate of the organisms. This subject will be discussed at length elsewhere.

It is significant, however, that the slow rate of disappearance of the static population during the winter months not only accounts for the presence of the organisms during that part of the year when they are unable to grow, but it also provides for a substantial seed population by the following spring, when conditions again become favorable for growth. The latter may be one of the chief reasons for the annual recurrence of the "small form" populations.

DISCUSSION

The "small forms," *Nannochloris* and *Stichococcus*, have been found to be particularly well adapted for growth under the peculiar physical and chemical conditions which occur in Great South Bay and Moriches Bay. In addition, it has been brought out that the slow flushing time of the bay waters allows for the retention of a considerable fraction of the summer bloom during the unproductive winter months, thereby providing for a substantial seed population on the following spring. This combination of circumstances alone is perhaps sufficient to account for the presence of "small form" blooms in these waters every year.

It is significant, however, that ecological conditions not only approach an optimum for the growth of the "small forms" but are also quite unsatisfactory for the development of the diatom, *Nitzschia closterium*. It is perhaps suggestive that the physiological characteristics of *Nitzschia* considered here are representative of diatoms, dinoflagellates, and other plankton flora normally found in unpolluted estuaries. While this provides a convenient hypothesis, such an assumption is unwarranted on the basis of the existing evidence.

The utilization of ammonia and amino acids by the green algae has been described by many workers (Schreiber, 1927; Braarud and Føyne, 1930; Algéus, 1946, 1949, 1950, and other papers). If diatoms in general are similar to *Nitzschia* in the matter of their nitrogen utilization, their absence from the summer blooms of Moriches Bay could be explained on that basis alone. This, however, does not appear to be the case.

Harvey (1940) found that natural populations of mixed diatoms could utilize nitrogen as nitrate, ammonia, urea, uric acid, and several amino acids, and that the growth of some species appeared to be better in ammonia than in nitrate. Chu (1943) observed that several diatoms (*Nitzschia palea*, *Fragilaria crotonensis*, *Asterionella gracillima*) grew equally well in ammonia or nitrate.

A recent paper by Harvey (1953) describes the exponential growth of *Nitzschia closterium* cultures in media containing ammonia as a source of nitrogen. Since

this is contradictory to the results of the experiments described in this paper, in which *Nitzschia* was found to grow very poorly in ammonia, these experiments were repeated, using both the artificial medium and natural sea water containing one mg. atom per liter of ammonia as a nitrogen source. The growth of *Nitzschia* in both of these media was equally as poor as that reported in the earlier experiments. Since the concentration of ammonia used here was probably higher than that employed by Harvey, there is the possibility that this was the factor which was toxic to the diatom (see Algéus, 1946) although it obviously was not so for either *Nannochloris* or *Stichococcus*. It is equally plausible that the *Nitzschia* used by Harvey and the present author represented different physiological varieties.

From the existing evidence of both the laboratory and the field observations, it appears that the only time of the year when organisms other than the "small forms" are able to dominate the phytoplankton is that period during which temperatures are too low to permit the growth of the Chlorophyta. In this respect, however, the natural situation in the bay waters differs somewhat from that which might be expected from the culture work. The experiments have shown that the "small forms" are able to grow very slowly if at all at the temperatures observed in the bays after October, while diatoms did not begin to flourish there until February. Although the bays were heavily enriched only during the duck growing season, relatively high concentrations of nutrients appear to be present throughout the year, presumably from the decomposition of the rich sediments in the tributaries receiving the duck farm effluents.

A remaining possibility exists that the absence of diatoms and other forms from the water between October and February may have been due, in part, to the production of inhibitory substances by the "small forms" and the accumulation of these products in the bay waters. This is suggested by the work of Pratt and his group (1944, and earlier papers) who found that *Chlorella* produces an antibiotic which inhibits its own growth, and by experiments of Rice (1949) who demonstrated that *Chlorella* and *Nitzschia frustrulum* produce substances which are mutually inhibitory.

Lefèvre and his co-workers (1951) have further shown that filtrates of both laboratory cultures and of pond water containing blooms of different species of algae produce inhibitory effects upon a wide variety of phytoplankton organisms.

It is perhaps significant that Pratt's group (Pratt, Oneto and Pratt, 1945) found that the maximum inhibitory effect of *Chlorella* was produced by senescent, non-dividing cultures, typical of the late fall and winter population of "small forms" in Great South Bay and Moriches Bay.

SUMMARY

1. The phytoplankton bloom in Great South Bay and Moriches Bay during the spring, summer, and early fall of 1952 consisted of the Chlorophyta, *Nannochloris atomus* and *Stichococcus* sp., to the virtual exclusion of other species. These organisms persisted throughout the year, but were accompanied by minor diatom blooms during the winter and early spring.

2. Growth rates of *Nannochloris*, *Stichococcus*, and the diatom, *Nitzschia closterium* were determined from laboratory cultures grown under various conditions

of temperature, salinity, and nutrients which are peculiar to the Great South Bay-Moriches Bay area.

3. *Nannochloris* and *Stichococcus* grew well in nitrogen present as nitrate, nitrite, ammonia, urea, uric acid, cystine, asparagin, and glycocoll. *Nitzschia* grew equally well in nitrate and nitrite, but showed poor growth in ammonia and the organic N compounds.

4. *Nannochloris* and *Stichococcus* grew approximately twice as fast in media containing an N : P ratio of 5 : 1 as they did in media with a 15 : 1 ratio of these elements. The growth rate of *Nitzschia* was the same in both media.

5. *Nannochloris* and *Stichococcus* appear to be brackish water forms with salinity optima of about 17‰, but both species grew well within a salinity range of 3–34‰. *Nitzschia*, a typical marine form, was unable to grow in low salinity water.

6. *Nannochloris* and *Stichococcus* grew at temperatures of 10–30° C., with very slight growth at 10° and an optimum range of 15–25°. *Nitzschia* grew within a temperature range of 5–25° with its best growth at 15°.

7. Pollution from duck farms bordering Moriches Bay heavily enriches the bay waters with plant nutrients. The presence of organic nitrogen compounds and the low ratio of nitrogen to phosphorus in the pollutants favor the growth of *Nannochloris* and *Stichococcus* over that of the more typical estuarine phytoplankton.

8. The peculiar nature of the pollutants together with low salinities and high water temperatures occurring at the time and place of maximum enrichment of the bay waters are factors which may explain the persistent dominance of the *Nannochloris-Stichococcus* community in the annually recurring plankton blooms in Great South Bay and Moriches Bay.

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